ELEC50001 EE2 Circuits and Systems

Problem Sheet 1

(Operation Amplifiers – Lectures 1 – 2)

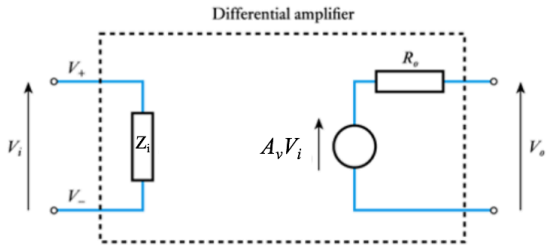
1. Download from the course webpage a copy of MCP601/2/4 operational amplifier datasheet. Based on this data sheet, answer the following questions assuming that VDD = 5V and VSS = 0V.

   a) This op-amp is modelled using the simplified circuit model shown below. Find the corresponding parameters from the datasheet where appropriate.

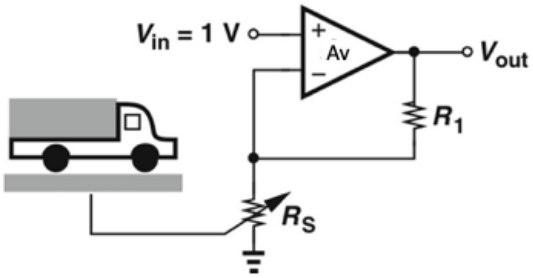
   b) What voltage range at the output?

   c) You are required to build a voltage amplifier for a signal in the frequency range of 10Hz to 100kHz, what is the maximum gain you can expect to achieve with one of these op-amps?

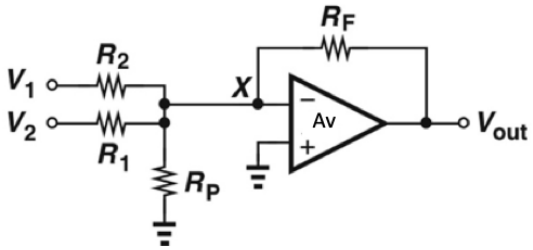
   d) This op-amp is used as a unity gain buffer amplifier (voltage follower) circuit. The input is driven directly with a 100kHz a digital clock signal between 0V and 3.3V. Sketch the expect output of the buffer amplifier.



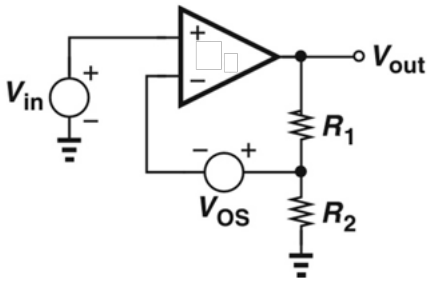
2. A truck weighing station incorporates a sensor whose resistance varies linearly with the weight: $R_S=R_0+\alpha W$. Here R_0 is a constant value, α a proportionality factor and W the weight of each truck. R_S is part of an amplifier circuit shown below. Given that V_{in}=1V, determine the gain of the system, defined as the change in V_{out} (i.e. δV_{out}) divided by the change in weight W (i.e. δW). You may assume that the op-amp is ideal.



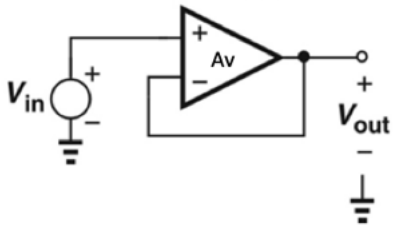
3. Due to a manufacturing error, a parasitic resistance R_P has appeared in the circuit below. Calculate V_{out} in terms of V_1 and V_2 for $A_V = \infty$ and $A_V < \infty$. (Note that R_P can also represent the input impedance of the op-amp). State any other assumptions used.



4. In the non-inverting amplifier shown below, the op-amp offset at its input is represented by a voltage source in series with the inverting input. Calculate Vout.

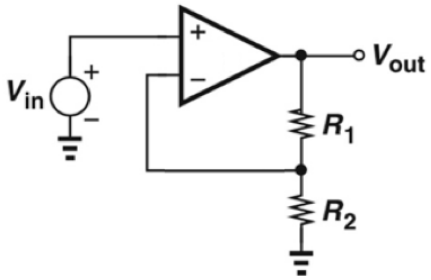


5. The unity-gain buffer shown below is designed to drive a 100Ω load with an acceptable gain error of 0.5%. Determine the required op-amp open-loop gain Av if the op-amp has an output impedance of 1kΩ.



6. The following circuit shows a non-inverting amplifier with a nominal gain of 4 if the op-amp were ideal. Unfortunately the op-amp is perfect except that it has a finite open-loop gain of Av at all frequencies. The specification requires the overall amplifier gain to be within 0.2%.

   Given that $R_1+R_2 = 20k\Omega$, determine the minimum value of Av.



7. An inverting amplifier shown below with a gain of -8 with a gain error of ±11% is required. What are the tolerance of the resistors R1 and R2, and what is the minimum open-loop gain of the op-amp required? You may assume that Rout and the input current of the op-amp are negligible. State any other assumption used.